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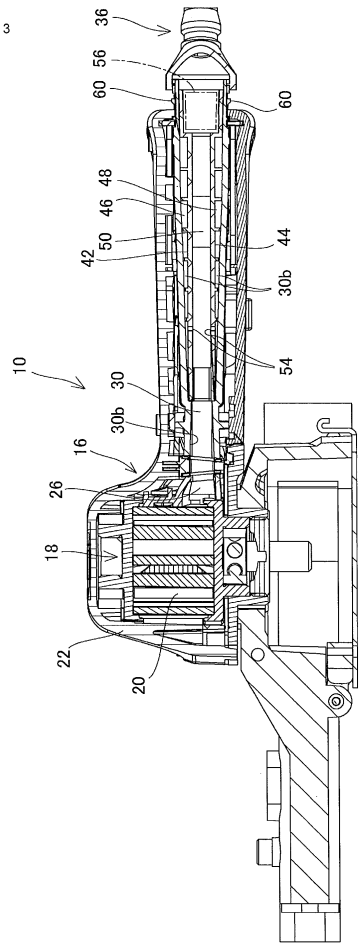
(54) PNEUMATIC TOOL PROVIDED WITH HELMHOLTZ SILENCING DEVICE

(57) [Technical Problem] Provided is an air tool configured to reduce noise from an air discharge path.

[Solution to Problem] An air tool (10) has a silencer member (40) provided in an air discharge path (30) in a housing (16) along a longitudinal direction of the air discharge path to divide the interior of the air discharge path into resonance chambers (46, 48) extending along the longitudinal direction of the air discharge path and an air discharge passage (50) extending in the longitudinal direction adjacently to the resonance chambers and divided from the resonance chambers to receive and pass exhaust air from a motor chamber (20) to a downstream outlet (30a). The silencer member (40) has openings (54) communicating between the air discharge passage (50) and the resonance chambers (46, 48). The openings (54) and the resonance chambers (46, 48) constitute a sound-damping chamber using Helmholtz resonance.

Fig. 3



EP 3 278 934 A1

Description

Technical Field:

[0001] The present invention relates to an air tool with a Helmholtz silencer. Background Art:

[0002] In air tools such as a pneumatic belt sander and a pneumatic torque wrench, which operate using compressed air as a drive source, compressed air is supplied to an air motor from an external air compressor connected to an air supply path in a housing of the tool, and exhaust air from the air motor is passed through an air discharge path in the housing and discharged to the outside.

[0003] Regarding the above-described air tools, there has been a demand for reduction in noise caused by exhaust air from the air motor, and various schemes for this purpose have been devised. For example, in an air tool disclosed in Patent Literature 1, an air discharge passage is provided therein with a tubular member (silencer) extending along the air discharge passage to divide the air discharge passage into an inner passage and an outer passage which are coaxial with each other. The tubular member is provided at each of its upstream and downstream ends with a plurality of circumferentially spaced openings. A part of exhaust air flowing through the air discharge passage from upstream to downstream is diverted (dispersed) into the outer passage through the upstream openings and joined with the exhaust air flowing through the inner passage through the downstream openings, thereby attempting to achieve a silencing effect by the diversion (dispersion) of exhaust air and the friction of the air with the openings and the passage walls. In an air tool disclosed in Patent Literature 2, an air discharge path is filled with glass wool (sound-deadening material), thereby attempting to achieve a silencing effect.

[0004] As a technique to reduce noise caused by a gas flowing through a flow path, Patent Literature 3 discloses a Helmholtz silencer for reducing engine intake noise which is formed by providing a resonance box (resonator) communicated with an intake path through a small-diameter passage extending from a side of the intake path.

Citation List:

Patent Literature:

[0005]

Patent Literature 1: Japanese Patent No. 3029092
Patent Literature 2: Japanese Patent Application Publication No. H05-138551
Patent Literature 3: Japanese Examined Patent Application Publication No. H03-4743

Summary of Invention:

Technical Problem:

[0006] An object of the present invention is to provide an air tool with a Helmholtz silencer having an unprecedentedly simple structure.

Solution to Problem:

[0007] The present invention provides an air tool with a Helmholtz silencer. The air tool includes the following: a housing having a motor chamber for accommodating an air motor, an air supply path for supplying compressed air to the motor chamber, and an air discharge path for passing exhaust air from the motor chamber to discharge the exhaust air to the outside from a downstream outlet; and a silencer member provided in the air discharge path along a longitudinal direction of the air discharge path to divide the interior of the air discharge path into a resonance chamber extending along the longitudinal direction of the air discharge path and an air discharge passage extending in the longitudinal direction adjacently to the resonance chamber, the air discharge passage being divided from the resonance chamber to receive exhaust air from the motor chamber and pass the exhaust air to the downstream outlet. The silencer member has an opening communicating between the air discharge passage and the resonance chamber. The opening and the resonance chamber constitute, in combination, a sound-damping chamber using Helmholtz resonance.

[0008] The air tool according to the present invention has the above-described Helmholtz silencer and is therefore capable of suppressing noise transmitted to the outside through the air discharge path.

[0009] Specifically, the arrangement may be as follows. The air discharge path extends rectilinearly from the downstream outlet upstream toward the motor chamber. The silencer member is inserted into the air discharge path from the downstream outlet toward an upstream side where the motor chamber is located, thereby dividing the air discharge path into the resonance chamber and the air discharge passage.

[0010] In one embodiment, the silencer member may have a plate-shaped partition wall configured such that when the silencer member is inserted in the air discharge path, the partition wall extends rectilinearly from the downstream outlet toward the upstream side, where the motor chamber is located, and the partition wall engages at peripheral edges thereof with an air discharge path wall defining the air discharge path, thereby dividing the interior of the air discharge path into the resonance chamber and the air discharge passage. In this case, the partition wall is provided with the opening.

[0011] The above-described configuration allows the air tool to be equipped with a Helmholtz silencer with a simpler structure.

[0012] More specifically, the arrangement may be as

follows. The silencer member has a plate-shaped second partition wall parallel spaced from the plate-shaped partition wall. The second partition wall is configured such that when the silencer member is inserted in the air discharge path, the second partition wall engages at peripheral edges thereof with the air discharge path wall, which defines the air discharge path. The two partition walls form a first and second resonance chambers, respectively, between themselves and the air discharge path wall. The air discharge passage is defined between the two partition walls, and the second resonance chamber and the air discharge passage are communicated with each other through an opening formed in the second partition wall.

[0013] Even more specifically, the first and second resonance chambers may be communicated with each other through a communicating path traversing the air discharge passage.

[0014] Further, the silencer member may have a connecting wall connecting respective downstream ends of the two partition walls.

[0015] In the above-described case, the air discharge passage may have a sound-deadening material provided in a space defined by the connecting wall and the two partition walls. The sound-deadening material may be configured to pass exhaust air flowing from upstream to downstream and to perform sound deadening.

[0016] The housing may have an air discharge pipe. The air discharge pipe may define the air discharge path.

[0017] The air discharge pipe may be detachable with respect to the housing.

[0018] One embodiment of an air tool according to the present invention will be explained below on the basis of the accompanying drawings.

Brief Description of Drawings:

[0019]

Fig. 1 is a side view of a belt sander as one embodiment of an air tool according to the present invention.
Fig. 2 is a top view of the belt sander shown in Fig. 1.
Fig. 3 is a sectional view taken along the line III-III in Fig. 1.
Fig. 4 is a sectional view taken along the line IV-IV in Fig. 2.
Fig. 5 is a perspective view of a silencer member to be inserted and installed in an air discharge path of the belt sander shown in Fig. 1.

Description of Embodiments:

[0020] A belt sander 10 is illustrated in the drawings as one embodiment of an air tool according to the present invention. The belt sander 10 includes an endless grinding belt 14 stretched around a pulley 12 set at a forward end (left end as seen in Fig. 1). The endless grinding belt 14 is driven by an air motor 18 provided in a housing 16. The structural and functional relation between the endless grinding belt 14 and the air motor 18 is disclosed, for example, in Japanese Patent Application Publication No. 2008-194769, and various techniques relating thereto are widely known to those skilled in the art; therefore, a detailed explanation thereof is omitted herein.

[0021] The housing 16 has a cylindrical motor-accommodating part 22 having a motor chamber 20 accommodating an air motor (vane motor) 18. The motor-accommodating part 22 has a peripheral wall portion provided with an air supply port 24 and an air discharge port 26 which are individually communicated with the motor chamber 20. The housing 16 further has a handle part 34 accommodating an air supply-discharge pipe 32 provided with an air supply path 28 and an air discharge path 30. The handle part 34 is configured to set the air supply-discharge pipe 32 so that the air supply path 28 and the air discharge path 30 are communicated with the air supply port 24 and the air discharge port 26, respectively.

[0022] When a grinding operation is to be performed with the belt sander (air tool) 10, the air supply path 28 is connected to an external air compressor, and an operation button 35 attached to the lower side of the housing 16 is pressed to open a switching valve 38 provided in the air supply path 28, thereby supplying compressed air into the motor chamber 20 through the air supply path 28 and the air supply port 24 to drive the air motor 18. Exhaust air from the motor chamber 20 is discharged to the outside through the air discharge port 26 and the air discharge path 30. The air discharge path 30 has an air discharge direction changing pipe member 36 attached to its right end (as seen in the drawings). The air discharge direction changing pipe member 36 allows the air discharge direction to be changed to a desired direction by rotating the air discharge direction changing pipe member 36 about the longitudinal axis of the air discharge path 30.

[0023] In the present invention, the air discharge path 30 of the above-described belt sander 10 is provided therein with a Helmholtz silencer (resonator) configured as explained below. The air discharge path 30 extends substantially rectilinearly from an outlet 30a at the right end toward the air discharge port 26 and has a silencer member 40, as shown in Fig. 5, inserted therein from the outlet 30a toward the air discharge port 26 and secured therein. The silencer member 40 has a plate-shaped first partition wall 42 and a plate-shaped second partition wall 44 which extend in the longitudinal direction of the air discharge path 30 and which are spaced from each other in a direction traversing the air discharge path 30, and a top connecting wall 45a and a bottom connecting wall 45b which connect the first partition wall 42 and the second partition wall 44 near the outlet 30a. The bottom connecting wall 45b is configured to contact a bottom surface 30c of the air discharge path 30. The first partition wall 42 and the second partition wall 44 substantially sealingly engage an air discharge path wall 30b defining the air

discharge path 30 at their respective upper edges 42a and 44a, lower edges 42b and 44b, and forward end edges 42c and 44c. The first partition wall 42 and the second partition wall 44 divide the interior of the air discharge path 30 into a first resonance chamber 46 and a second resonance chamber 48 which are laterally spaced from each other, and an air discharge passage 50 extending in the longitudinal direction of the air discharge path 30 between the two resonance chambers to receive and pass exhaust air from the motor chamber 20 to the outlet 30a of the air discharge path 30. In the illustrated embodiment, the silencer member 40 has an inclined plate 52 provided at the left end (as seen in the figure) of the silencer member 40. The inclined plate 52 connects the lower portions of the first and second partition walls 42 and 44. Between a lower surface 52a of the inclined plate 52 and the air discharge path wall 30b is formed a communicating path 53 communicating between the first resonance chamber 46 and the second resonance chamber 48. The first resonance chamber 46 and the second resonance chamber 48 form, in combination, a single resonance chamber. The first partition wall 42 and the second partition wall 44 are each formed with a single small opening 54. The openings 54 and the resonance chamber form a Helmholtz silencer using Helmholtz resonance.

[0024] The silencer member 40 is capable of being loaded and unloaded through the outlet 30a of the air discharge path 30, and a sound-deadening material 56, e.g. glass wool, can be set in a portion of the silencer member 40 at the bottom connecting wall 45b at the right end thereof in such a way that the sound-deadening material 56 is sandwiched between the first partition wall 42 and the second partition wall 44. In the illustrated embodiment, the first partition wall 42 and the second partition wall 44 have engaging projections 60 provided at their right ends, respectively. The engaging projections 60 are urged outward. The silencer member 40 is secured by engaging the engaging projections 60 with respective holes (not shown) provided in the air discharge path wall 30b to extend therethrough. The silencer member 40 can be removed from the air discharge path 30 by pushing the engaging projections 60 inward to disengage from the holes. Accordingly, the sound-deadening material 56 can be replaced easily by removing the silencer member 40 from the air discharge path 30. In the illustrated embodiment, the first partition wall 42 and the second partition wall 44 have ribs 58 provided on their outer surfaces, respectively, so that the ribs 58 engage the air discharge path wall 30b to support the partition walls 42 and 44.

[0025] The air tool 10 according to the present invention is provided with a Helmholtz silencer formed as stated above and is therefore capable of damping noise transmitted from the air discharge path to the outside. It should be noted that a Helmholtz resonator is known to have, in principle, one opening provided for one resonance chamber. It has, however, been confirmed that a silencing effect can be obtained also with a Helmholtz resonator provided with a plurality of openings.

[0026] Although an embodiment in which the present invention is applied to a belt sander has been explained above, the present invention is not limited thereto but may be widely applied to air tools provided with an air discharge path for discharging exhaust air from an air motor.

List of Reference Signs:

[0027]

Belt sander 10
Endless grinding belt 14
Housing 16
Air motor 18
Motor chamber 20
Motor-accommodating part 22
Air supply port 24
Air discharge port 26
Air supply path 28
Air discharge path 30
Outlet 30a
Air discharge path wall 30b
Air supply-discharge pipe 32
Handle part 34
Operation button 35
Air discharge direction changing pipe member 36
Switching valve 38
Silencer member 40
First partition wall 42
Upper edge 42a
Lower edge 42b
Forward end edge 42c
Second partition wall 44
Upper edge 44a
Lower edge 44b
Forward end edge 44c
Top connecting wall 45a
Bottom connecting wall 45b
First resonance chamber 46
Second resonance chamber 48
Air discharge passage 50
Inclined plate 52
Lower surface 52a
Communicating path 53
Openings 54
Sound-deadening material 56
Ribs 58
Engaging projections 60

Claims

1. An air tool with a Helmholtz silencer, the air tool comprising:

a housing including a motor chamber for accom-

modating an air motor, an air supply path for supplying compressed air to the motor chamber, and an air discharge path for passing exhaust air from the motor chamber to discharge the exhaust air to an outside from a downstream outlet; and

a silencer member provided in the air discharge path along a longitudinal direction of the air discharge path to divide an interior of the air discharge path into a resonance chamber extending along the longitudinal direction of the air discharge path and an air discharge passage extending in the longitudinal direction adjacently to the resonance chamber, the air discharge passage being divided from the resonance chamber to receive exhaust air from the motor chamber and pass the exhaust air to the downstream outlet;

the silencer member having an opening communicating between the air discharge passage and the resonance chamber, the opening and the resonance chamber constituting, in combination, a sound-damping chamber using Helmholtz resonance.

2. The air tool of claim 1, wherein the air discharge path extends rectilinearly from the downstream outlet upstream toward the motor chamber;

the silencer member being inserted into the air discharge path from the downstream outlet toward an upstream side where the motor chamber is located, thereby dividing the air discharge path into the resonance chamber and the air discharge passage.

3. The air tool of claim 2, wherein the silencer member has a plate-shaped partition wall configured such that when the silencer member is inserted in the air discharge path, the partition wall extends rectilinearly from the downstream outlet toward the upstream side, where the motor chamber is located, and the partition wall engages at peripheral edges thereof with an air discharge path wall defining the air discharge path, thereby dividing the interior of the air discharge path into the resonance chamber and the air discharge passage, the partition wall being provided with the opening.

4. The air tool of claim 3, wherein the silencer member has a plate-shaped second partition wall parallel spaced from the plate-shaped partition wall, the second partition wall being configured such that when the silencer member is inserted in the air discharge path, the second partition wall engages at peripheral edges thereof with the air discharge path wall, which defines the air discharge path, the two partition walls forming a first and second resonance chambers, respectively, between themselves and the air discharge path wall, the air discharge passage being defined between the two partition walls, the second resonance chamber and the air discharge passage being communicated with each other through an opening formed in the second partition wall.

5. The air tool of claim 4, wherein the first and second resonance chambers are communicated with each other through a communicating path traversing the air discharge passage.

6. The air tool of claim 4 or 5, wherein the silencer member has a connecting wall connecting respective downstream ends of the two partition walls.

7. The air tool of claim 6, wherein the air discharge passage has a sound-deadening material provided in a space defined by the connecting wall and the two partition walls, the sound-deadening material being configured to pass exhaust air flowing from upstream to downstream and to perform sound deadening.

8. The air tool of any of claims 1 to 7, wherein the housing includes an air discharge pipe, the air discharge pipe defining the air discharge path.

9. The air tool of claim 8, wherein the air discharge pipe is detachable with respect to the housing.

Fig. 1

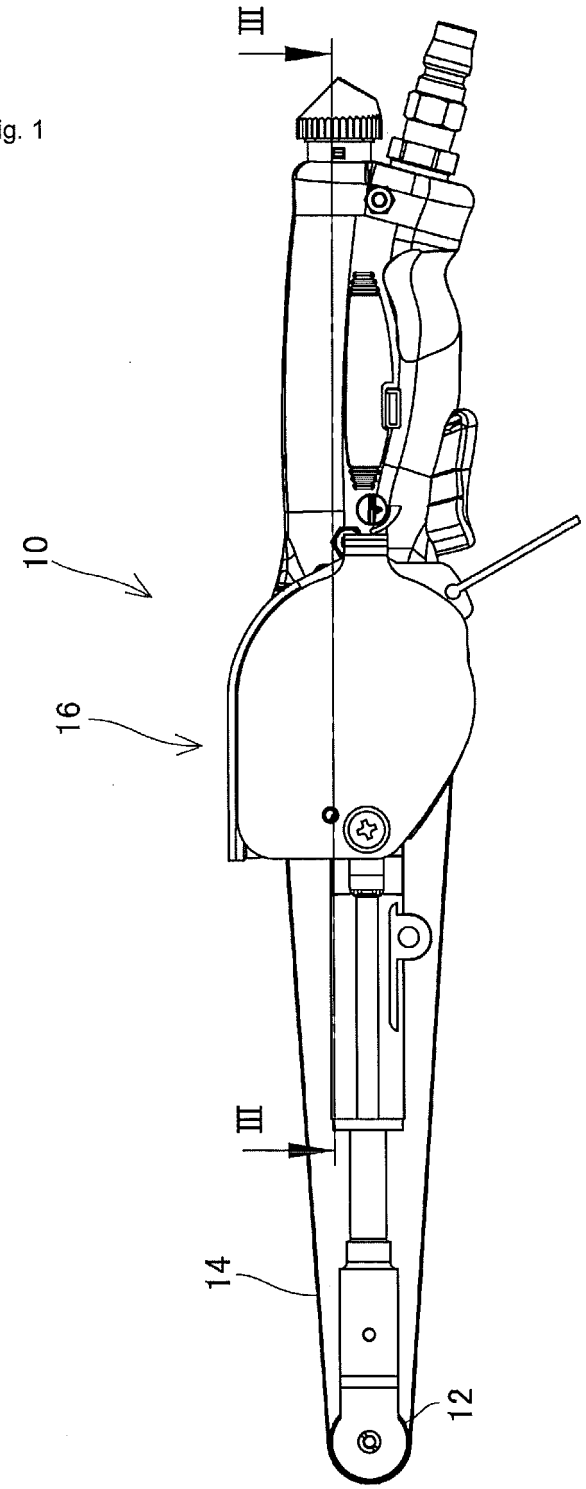


Fig. 2

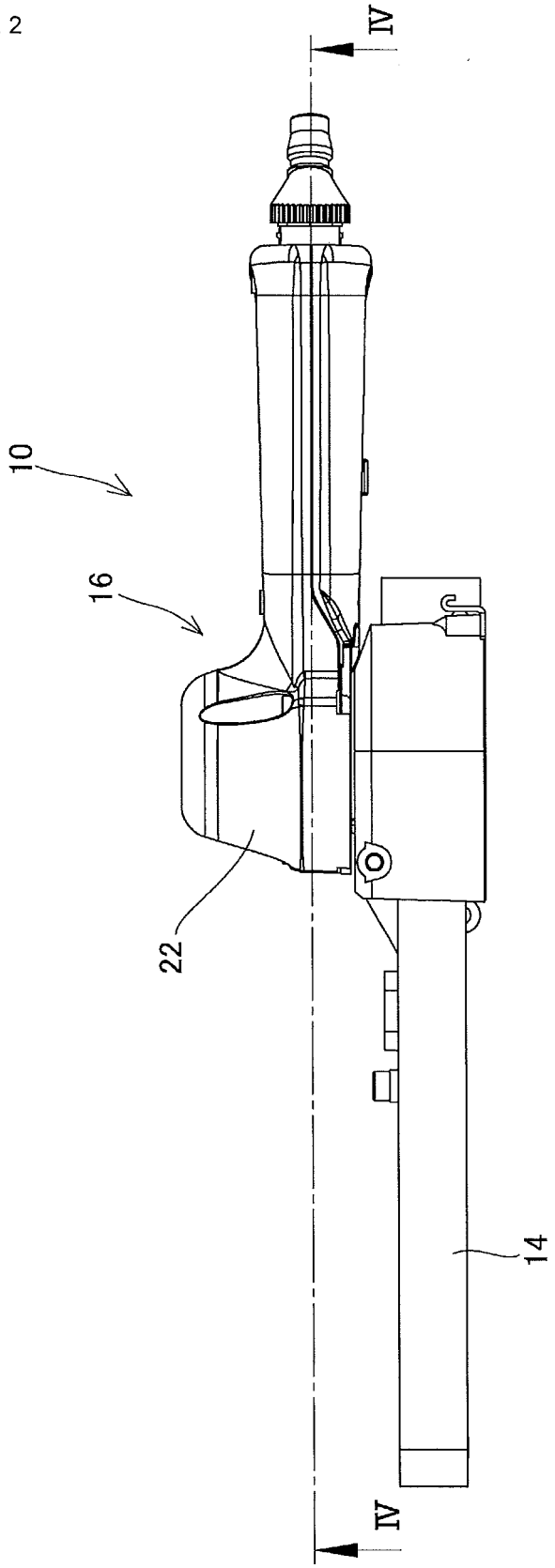


Fig. 3

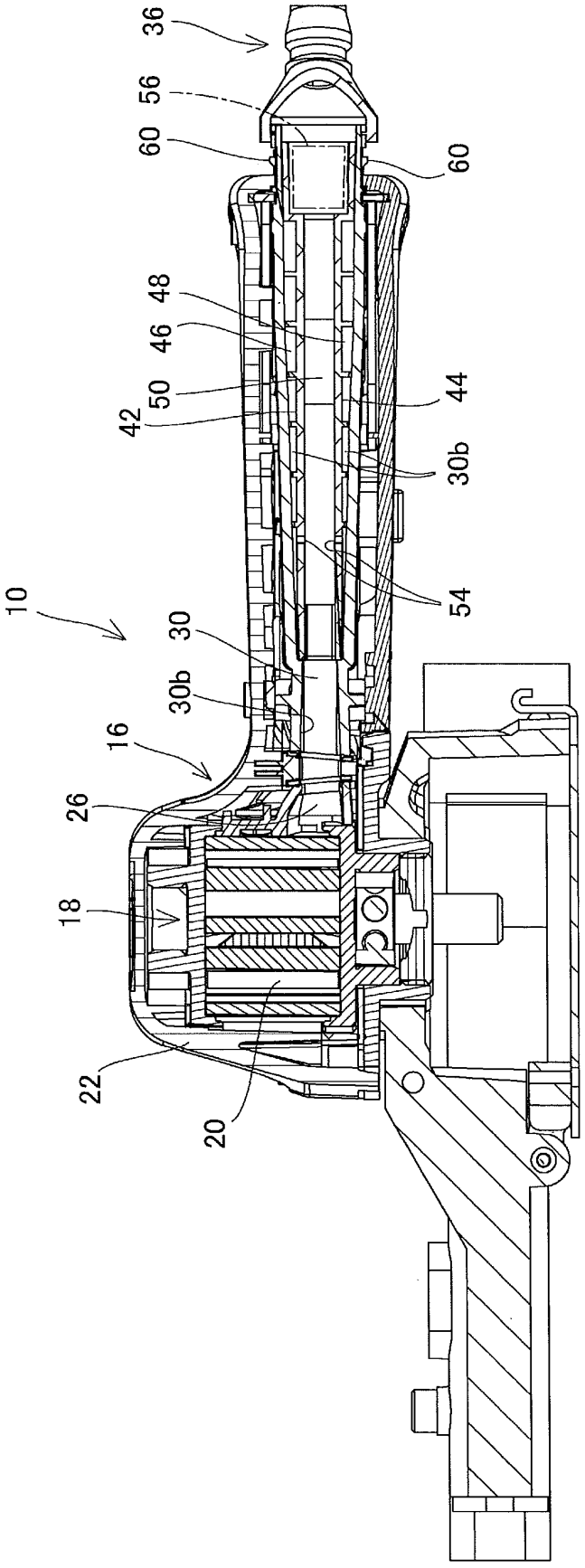
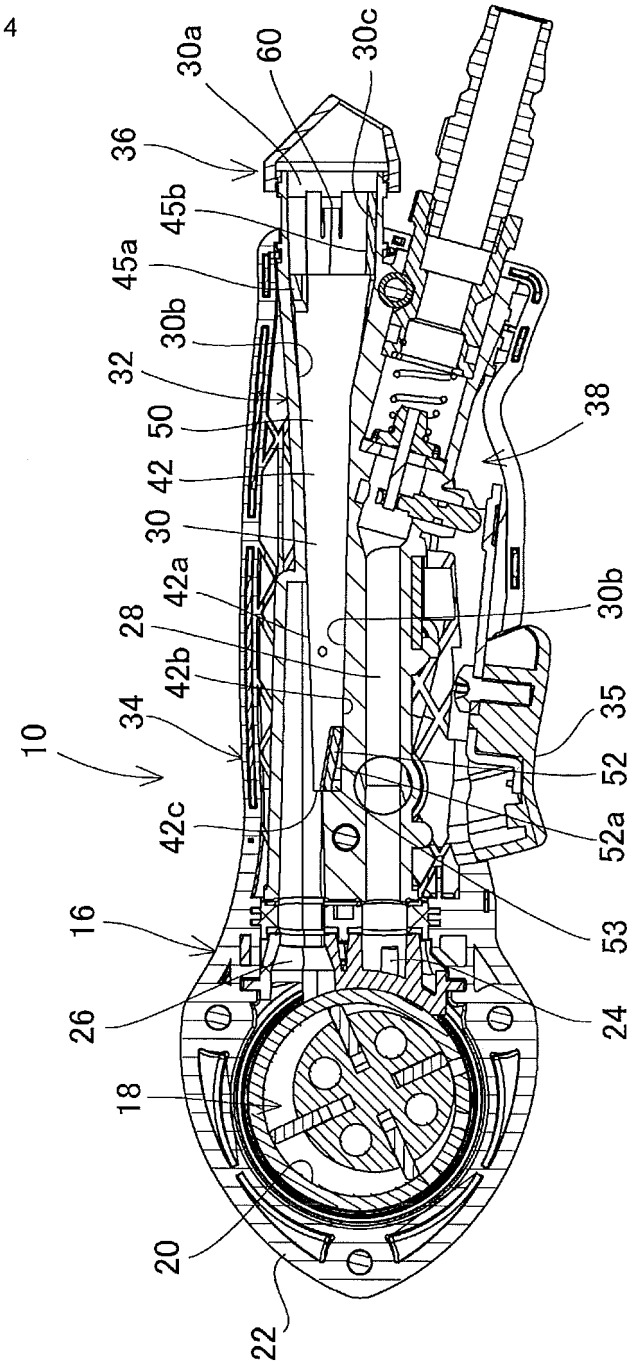


Fig. 4


30a
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45b
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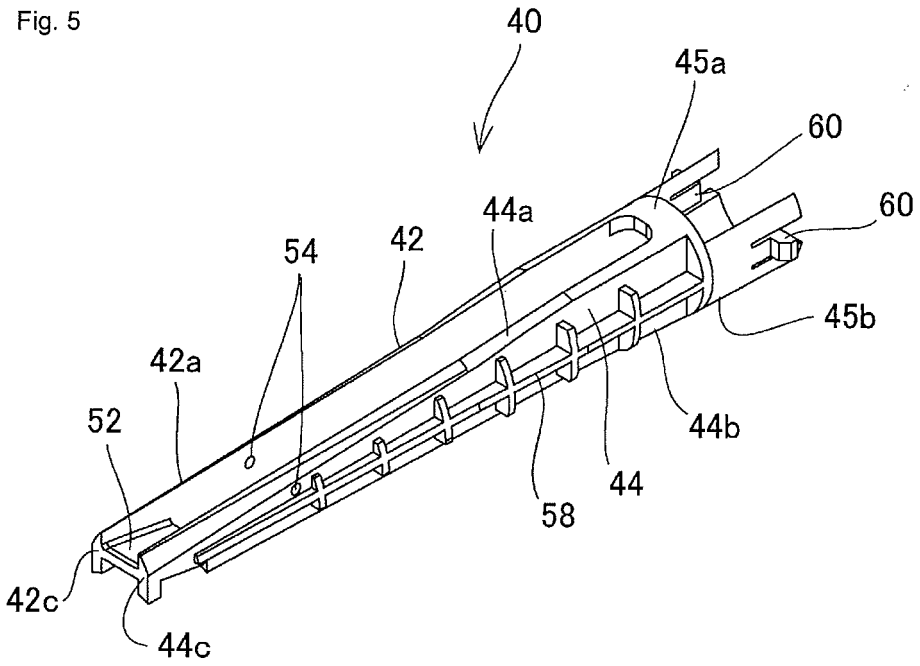
Fig. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/060001

A. CLASSIFICATION OF SUBJECT MATTER
B25F5/00(2006.01)i, *F01N1/02*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B25F5/00, F01N1/02, B25C1/04, B25B21/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2016
Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI(Thomson Innovation)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	US 4023645 A (DONALDSON COMPANY, INC.), 17 May 1977 (17.05.1977), column 2, lines 23 to 53; fig. 1 (Family: none)	1-2,8-9
Y	JP 2006-144557 A (Mitsubishi Heavy Industries, Ltd.), 08 June 2006 (08.06.2006), paragraphs [0034] to [0037] (Family: none)	1-2,8-9

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 May 2016 (26.05.16)	07 June 2016 (07.06.16)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/060001

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 8-152889 A (Osaka Yakin Kogyo Co., Ltd.), 11 June 1996 (11.06.1996), fig. 6 (Family: none)	1-2,8-9
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REFERENCES CITED IN THE DESCRIPTION

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- JP H05138551 B **[0005]**
- JP H034743 B **[0005]**
- JP 2008194769 A **[0020]**